Field Evaluation of Alternative Isolation Joints at O'Hare

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Thanks

- O'Hare Modernization Program (money!)
- Ross Anderson of Bowman, Barrett & Associates, Inc. (access!)
- Dr. David Brill of FAA Airport Pavement Technology R&D Branch (brains!)
- ERI, Inc. (equipment!)
- Undergrads (free labor!)

Outline

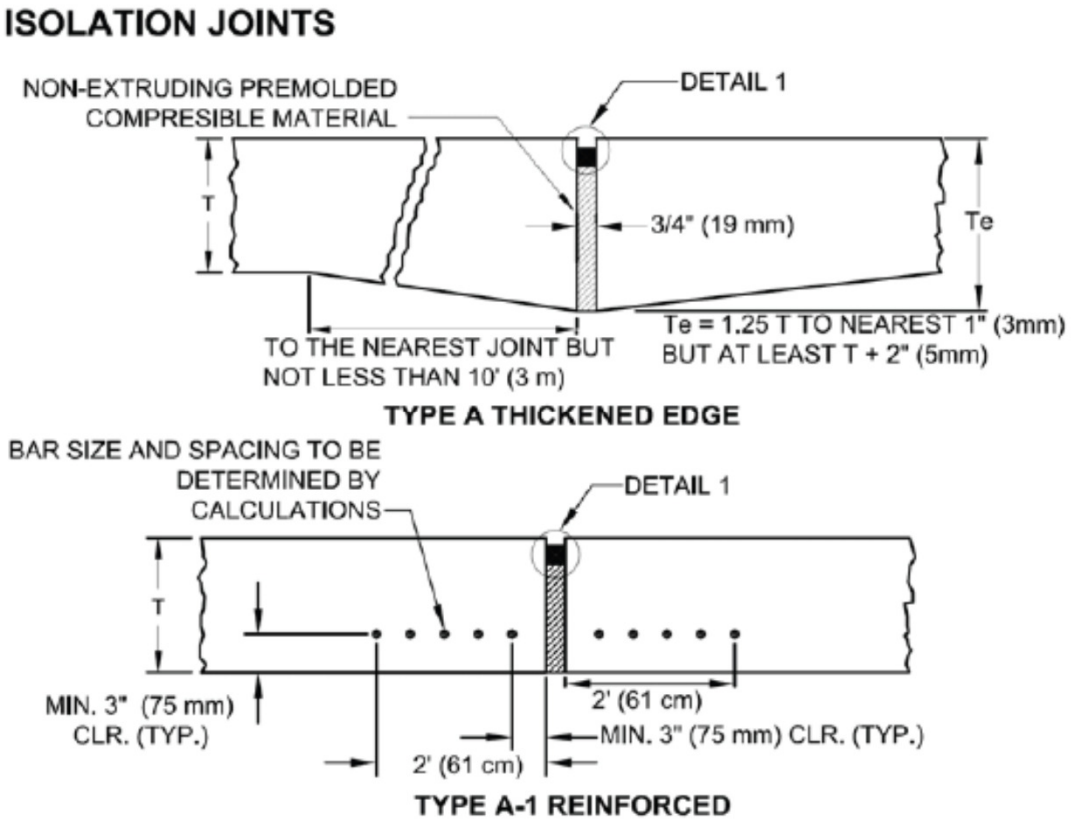
- Introduction to joint design
- Project objectives
- Field instrumentation
- Data analysis
- Discussion
- Conclusions

Isolation Joint Design

- Joints used in areas where there is differential slab movement expected
  - Commonly employed at the intersections of taxiways and runways

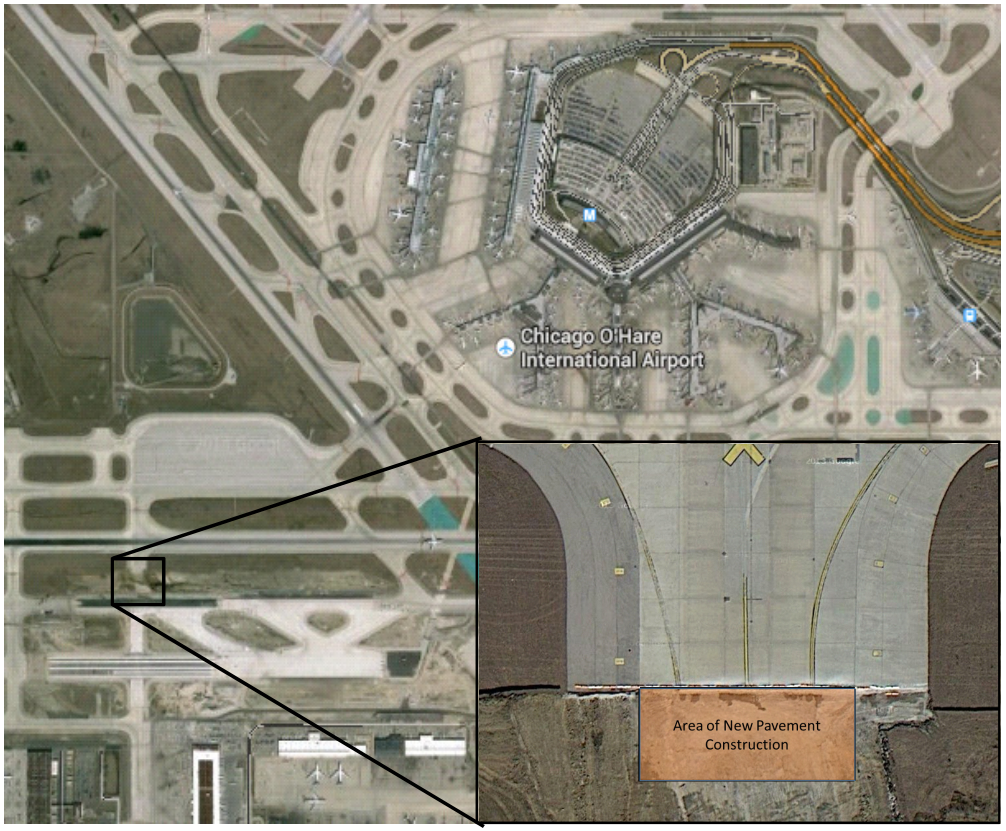
Isolation Joint Design

- FAA allows for two designs



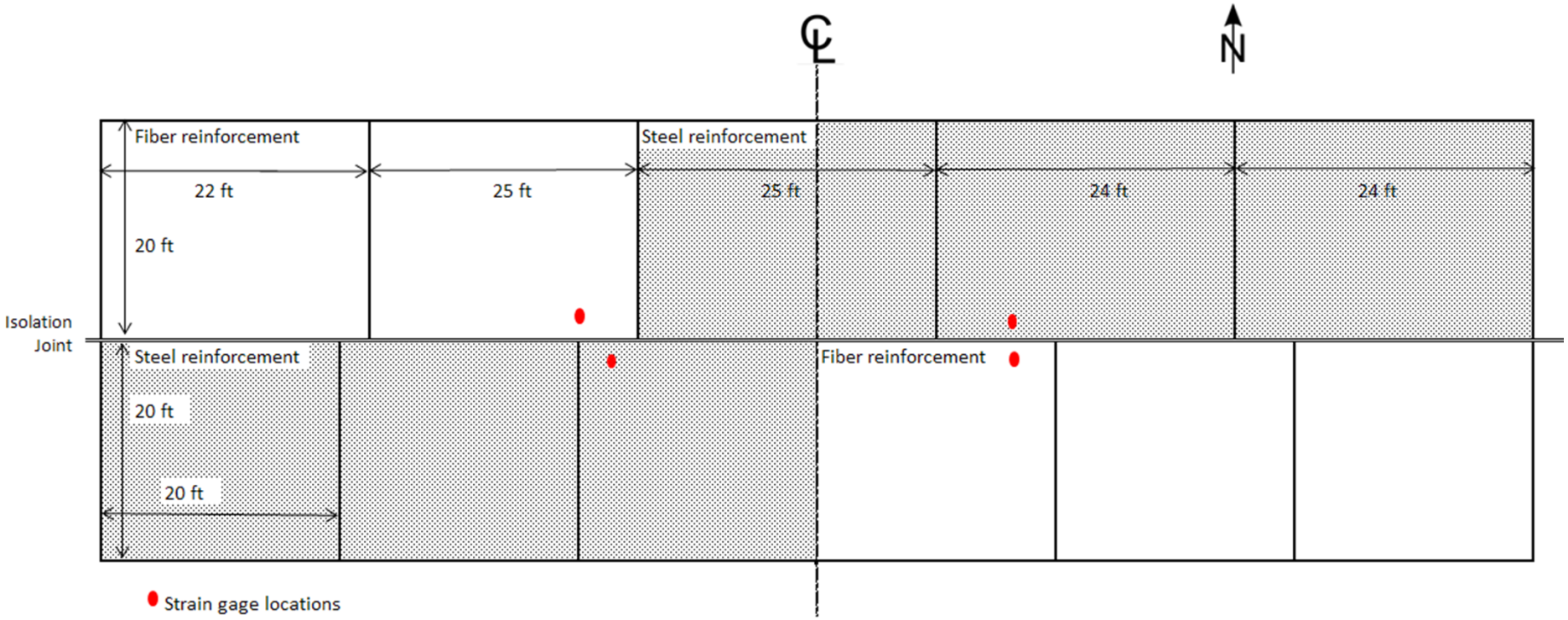
Project Objectives

- Does the Type A-1 (reinforced) isolation joint design perform adequately under live aircraft loading?
- Does a novel, fiber reinforced isolation joint design perform adequately under live aircraft loading?



Field Instrumentation

- Four strain gauge trees located on opposite sides of the isolation joint
  - Each gauge tree held two strain gauges two inches from the top and bottom surface



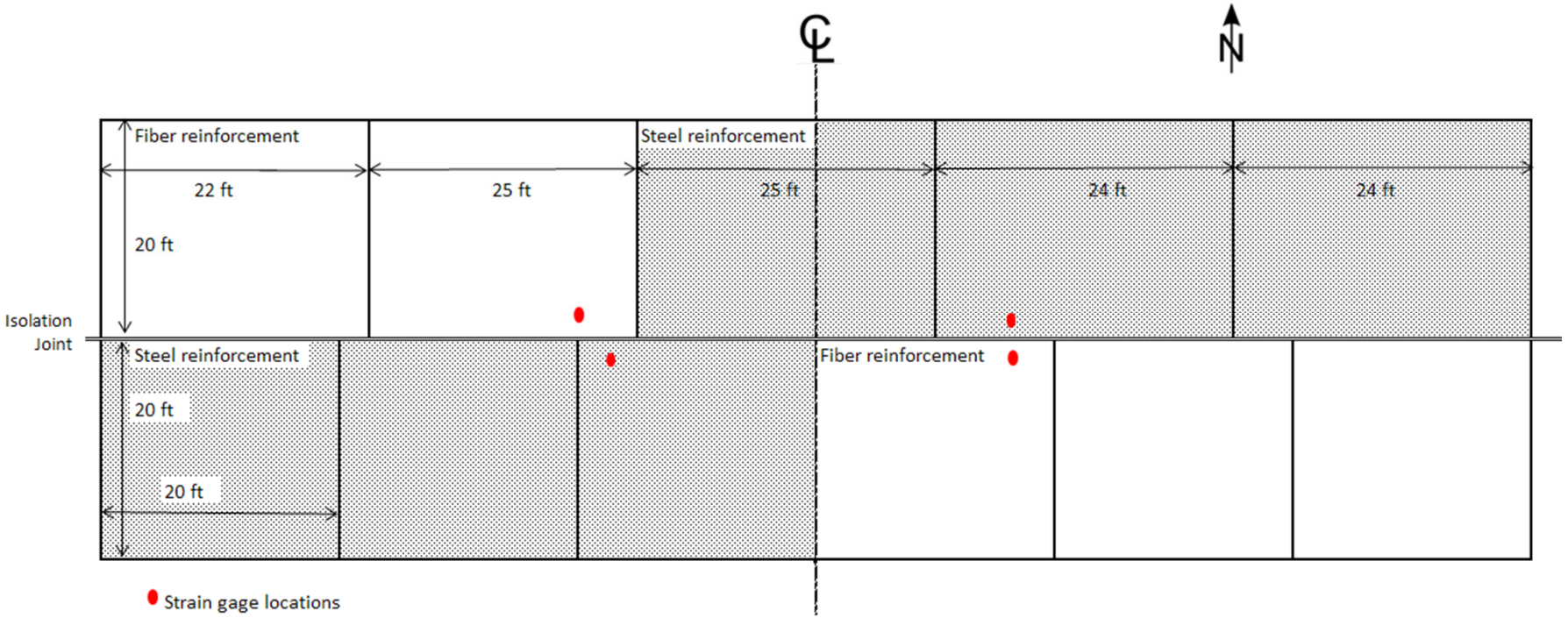
Field Instrumentation

Field Instrumentation

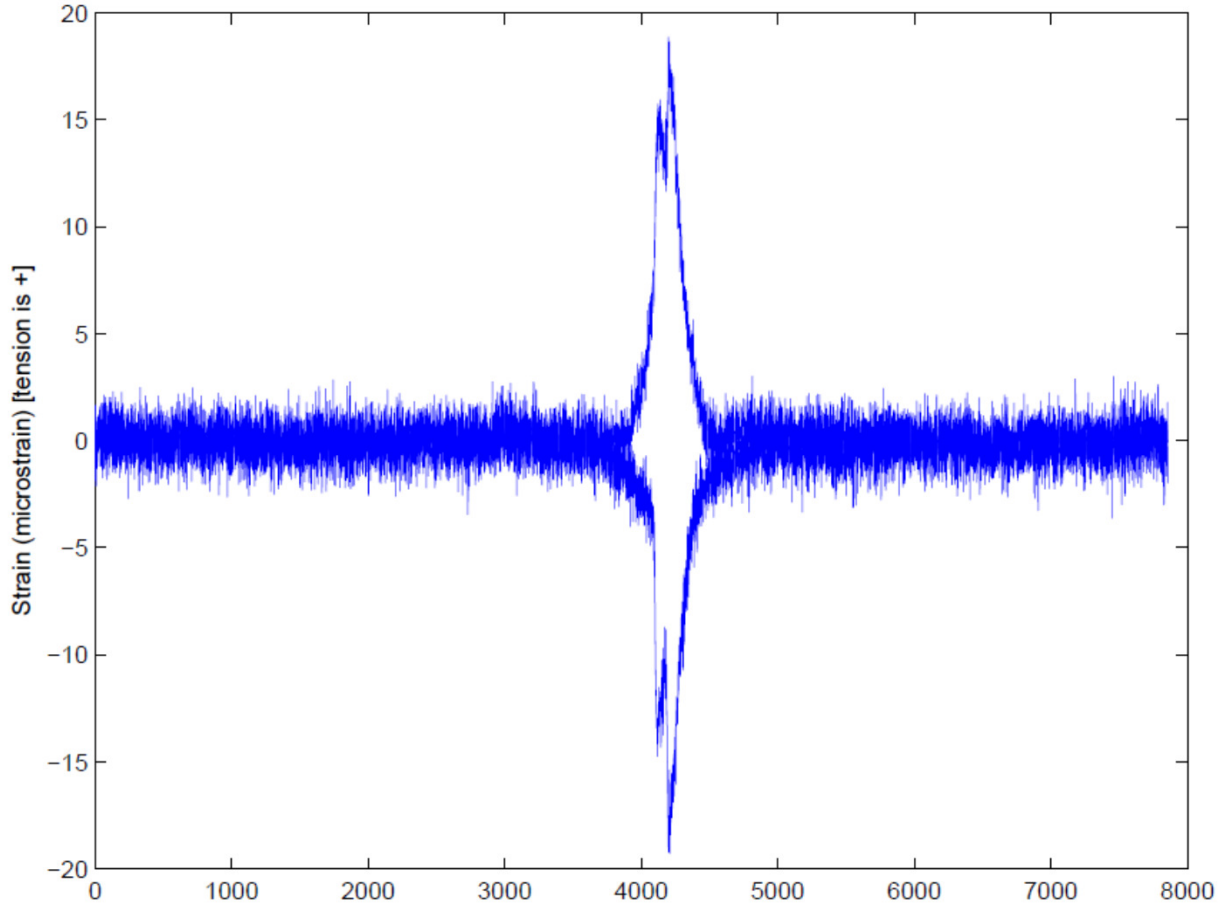
- Data recorded using UIUC Mobile Research Lab

Field Instrumentation

- Only west side sensors were monitored during live aircraft loading due to safety concerns accessing the buried wires.
  - Also, our escort didn't like me going around digging a bunch of holes trying to find the wires



Data Analysis



Data Analysis

Data collected from 04:00 to 06:00 on November 11, 2013

Flight	Aircraft	Fiber Section (Embedded)	Steel Section (Embedded)	Steel Section (Rebar)
FDX1950	A300B4	7.6	18.9	16.0
FDX1706	DC-10-10F	24.8	14.3	13.4
FDX1447	MD-11F	11.5	22.9	20.4
FDX1157	DC-10-10F	10.0	21.3	18.2
FDX1405	DC-10-10F	11.7	20.3	21.5

Fiber section: 25’ x 20’ slabs
Steel section: 20’ x 20’ slabs

Data Analysis

- ILLI-SLAB was used to analyze the data and the field data was used to calibrate the analysis by establishing an offset for each aircraft

Aircraft	Fiber Section Embedded (με)	Fiber Section ILLI-SLAB (με)	Steel Section Embedded (με)	Steel Section ILLI-SLAB (με)	Offset (ft)
A300B4	7.6	7	18.9	19	1.5, W
DC-10-10F	24.8	22	14.3	9	6.0, E
MD-11F	11.5	12	22.9	24	2.5, E
DC-10-10F	10.0	8	21.3	22	2.0, E
DC-10-10F	11.7	8	20.3	22	2.0, E

Fiber section: 25’ x 20’ slabs
Steel section: 20’ x 20’ slabs

Data Analysis

Aircraft	Isolation Joint Edge Stress (psi)	
	Fiber Reinforced	Thickened Edge
A300B4	479	335
DC-10-10F	266	185
MD-11F	301	212
DC-10-10F	332	233
DC-10-10F	332	233

Slab size: 25’ x 20’

Tested Flexural Strength > 900 psi

Data Analysis

Aircraft	Isolation Joint Edge Stress (psi)	
	Steel Reinforced	Thickened Edge
A300B4	526	365
DC-10-10F	262	182
MD-11F	315	220
DC-10-10F	341	237
DC-10-10F	341	237

Slab size: 20’ x 20’

Tested Flexural Strength > 900 psi

Data Analysis

Airbus 300B4
LTE 76% (measured)

	Loading Case	Peak Tensile Stress, psi
25’x20’ slabs	Fiber Reinforced Section	301
	Fiber Reinforced Section Thickened Edge	214
20’x20’ slabs	Steel Reinforced Section	331
	Steel Reinforced Section Thickened Edge	235

Discussion

- Without the thickened edge, the stress is higher. Is that bad?
  - Not necessarily, we have two cases:
  1. No load transfer (e.g. granular base layer)
  2. We consider the load transfer effects from the stabilized base layer

Section	No Load Transfer	76% Load Transfer	FAA N100 Limit	FAA N80 Limit
25'x20' slabs	479	301	1.9 million	2.6 million
25'x20' slabs (thickened)	335	214	2.4 billion	3.4 billion
20'x20' slabs	526	331	400,000	534,000
20'x20' slabs (thickened)	365	235	271 million	369 million

Conclusions

- Type A-1 and fiber reinforced joint design produces more stress than an equivalently modeled thickened edge joint design
- Higher stress for the alternative joint designs has an impact on the fatigue life, but not expected to be a concern due to other failure mechanisms
- Using an alternative joint design must coincide with the use of a stabilized base to prevent excessively high free edge stresses
- Alternative joint designs appear to be viable but the topic requires significantly more testing and field data
  - Instrumentation of taxiways/aprons/runways cannot be haphazard

Questions? (ask my son, he's smarter albeit sillier)